

Food Traceability in Supply Chain Based on EPCIS Standard and RFID Technology

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Abstract

The growth of retailer lately very significant especially in food product, selling of food product is not only in conventional market but moreover now is in such mini market, mall, shopping complex, etc. Food traceability is required in supply of food product to make sure items are safe to consume and not in expired date. This paper present on food traceability in supply chain based on Electronic Product Code Information Services (EPCIS), the use of EPCIS standard is refer to Global Standard-1 (GS1) for logistic and supply chain based on Radio Frequency Identification (RFID) Technology. RFID is used for items tagging on food product instead of barcode that currently widely used the advantages of RFID tag compare than barcode make the system is more applicable to used in food traceability. In this case one of food product take into example in supplying which is banana that the process started from farmer until reach to retail house are monitored and recorded by the system. End process of this system is to give services to the consumer of customer based on EPCIS database collected in all the way of process. Implementation of this system be able to track and trace of food product information that can be use or require by user or logistic companies.

Keywords: food, traceability, EPCIS, RFID, supply chain

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1. Introduction

Nowadays, food products are supplied from various places or countries with the distance from producer or farmer over the regions or country, furthermore food travels from producer to consumer took much time to reach to retailer or consumer. Therefore, food safety and quality along the way of food supplied is required in order to make sure food product is fresh in good to consume. In order to prevent unexpected case into food product happen such recall, need a system that ability to trace about food sources and supplier. It is not only retailers must insist that everyone in the supply chain as their suppliers, but also their suppliers. Traceability of food product in supply chain has gained considerable importance with regard to food, particularly following a number of food safety cases during delivery. However, most of logistic companies today do not have the ability to manage inventory across an extended network of suppliers, distributors, manufacturers and producers. As a result, a lack of visibility and monitoring into the supply chain has enabled such occurrences as the illegal substitution of food product in the food supply chain to arise, and continue unchecked.

A method to provide safe and good food product is by trace and monitor all the way started from preparation (manufacturing or farming) to reach user (consumer) is traceability system. Product traceability is the ability to track and monitor movement of a product started from delivery until reach to destination. Food product traceability and monitoring included all stages of process such as, preparation, production, processing and distribution. Food product processing involve in traceability and identify of the source all for input component for processing, such as raw materials, additives, ingredients, packaging. Implementation of food

product traceability enables corrective action in case of something happen on the product either safety or defective. When a case of product potentially identified or happen then quick action can be done by food business or related government to isolate or quarantine to prevent contamination to other product before reaching consumers. The other way, if case happens while food product consumed by consumer also can be rectify immediately before scattering to other consumers.

EPCIS is an EPC global standard for sharing data and information related EPC between trading and partners. Its streamlines product traceability and product tracking by providing a way for disparate applications to use EPC data. EPCIS provides important new capabilities to improve efficiency, security, and visibility in global supply chains, and complements lower level EPC global tag, reader and middleware standards [1]. An Electronic Product Code (EPC) is a unique serialized identifier for any kind of item; EPC basically is under concept of Radio Frequency Identification (RFID) technology. RFID is used to describe various technologies that use radio waves to automatically identify human or objects. RFID technology concept is similar to the bar code identification systems concept as we seen in retail stores every day, however one big difference between RFID and bar code technology is that RFID does not required line of sight reading as bar code scanning requires line of sight reading [2]. The component of radio frequency identification system consists of tag, readers and backend system (computing system) for processing the information received by the readers [3]. By added RFID technology into food supply chain traceability then a product easily and fully monitored by supplier or consumer, in case something goes wrong easy to identify.

Some of research related to food traceability has been done, one of topic was discussed on framework for the evaluation of a traceability system for the agri-food industry [4-5]. The automation level in an RFID-based traceability system is analyzed and compared with respect to traditional ones [6-7]. Internal and external traceability's are both considered and formalized, in order to classify different environments, according to their automation level [8] but in this research focusing only the framework and process flow of the traceability system. Another research in traceability system is developing in the wine production sector by joining this RFID technology with the use of wireless sensor networks for monitoring at the vineyards [9]. Traceability for a live fist from farmer to retailer written as [10] is for animal food product. EPCIS data management and framework for food product traceability shown in [11-12] enable to send all information to EPC database for consumer information.

This research proposes a new system for food product traceability complete started from farming (production/manufacturing) until user reach to destination or consumer. EPCIS standard used for information and database as supply chain data centralized for manufacturer, logistic, retailer and consumer. Cloud-based traceability applications can capture data from all of these sources, translate it into common formats and integrate it into appropriate applications for processing, providing farm to supply chain visibility. RFID EPC Gen2 tag [13] used in product traceability of food product. Where, an RFID tag used as identification in every parcel (pallet) of product. Supply chain technology ability to propose proper and efficient process for the food product so minimize the risk of food contaminate or mix to others during delivery.

2. Supply Chain System in Food Product

Supply chain management system is a flow system for goods or products including the movement and storage of raw materials, work-in-process inventory and finished goods from point of origin (manufacturer or farmer) to point of retail (consumption). Supply chain management system has been defined as the design, planning, execution, control and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally. Supply chain system gives the ability to quickly and effectively process orders in delivery to ensure customer needs are addressed quickly. The concept of supply chain management is based on two core ideas, firstly is that practically every product that reaches at end user represents in effective time and secondly is that the product delivery to the user in safe and secure to consume. Supply chain management is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. This represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Proposed supply chain

activities cover from product development, sourcing, production and logistics, as well as the information systems needed to coordinate these activities. The organizations that make up the supply chain are “linked” together through physical flows and information flows. Physical flows involve the transformation, movement and storage of goods and materials. Figure 1 shows how is a complete of supply chain management system work stated from processing, delivery system and reach to the customer. In order to monitor quality and security of a food product, monitoring need to start from first process for example bananas fruit, starting from plantation (location), cutting and processing, packing and delivery then retailing and reach to user for consume. All the plantation location and product batch to be tagged and classified according to the delivery and the data stored in a big central data based to be shared to other parties.

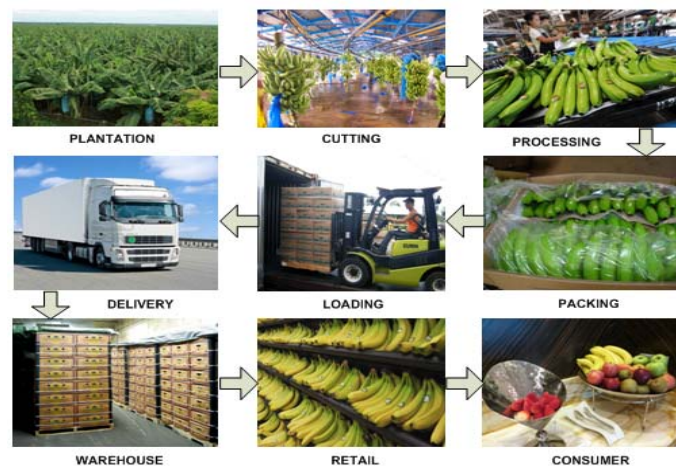


Figure 1. Food product supply chain management system.

3. Food Traceability Used EPCIS Standard

Food product traceability can be defined as the information necessary to describe from production history of a food crop and processes of the crop might be subject to on its journey from the grower to the consumer. The ability to collect the information as much as possible and use it to ensure product quality in “real time” provides tangible benefits to the food industry. It provides a greater assurance of food product quality and enables faster identification of problems. It also provides the procedure for communicating to the consumer the diligence with which a business operates. Information technology has developed over the last decade to a point where it can quickly and efficiently move, store and analyze vast volumes of data. As the use of personal computers continues to rise, access to appropriate technology and software systems is increasing amongst all members of the food supply chain. To solve the problems of data collection, transmission and analysis within the industry, there must be a common and standard means of communication, available to all [14-15].

RFID is a technology can be use as alternative solution for product identification and traceability. Figure 2 shows a traceability of food started from factory or manufacturer, where every product labeled and tagged with an RFID tag that programmed with original information then bring to freight forwarder for delivery. Once item tagged with information tag, every step of delivery process can be trace by system and all the information will send to data centre then user or customer able to see the location and status of goods. Normally, every retailer or supermarket has own warehouse for stocking the goods and before entering warehouse every product scanned by RFID system at the entrance to make sure correct product and in good condition. Retailer shows or display product to sell at dedicated location then customer be able to check the goods especially food product before buying, with this system customer by using smart phone or tablet able to scan selected product to check all the information and status.

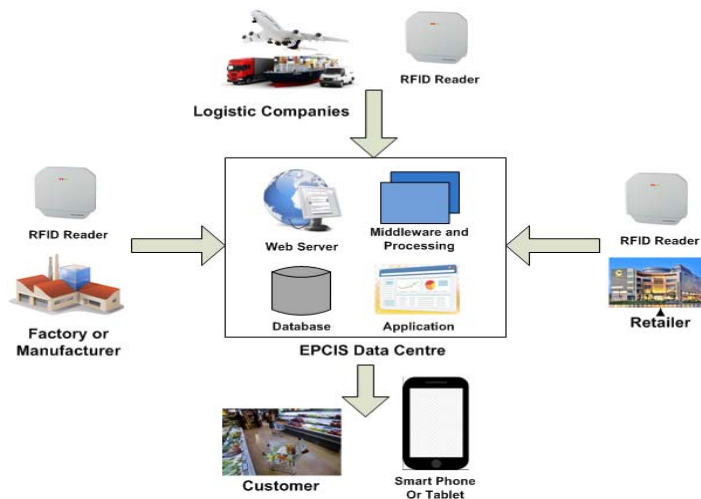


Figure 2. EPCIS traceability data centre in supply chain system

The GS1 standard is the most widely used in supply chain management system, GS1 system is an integrated system of global standards that provides for identification and communication of information regarding locations, products, assets, services and locations. The GS1 identification standards, known as GS1 Identification keys, bring value by permitting secure and portable identification across technologies such as barcodes, RFID tags and electronic messages and by connecting the physical flow of goods and services to the flow of information. Transport & Logistics industry involves the movement of goods using multiple transport modes, including road, rail, air and maritime. Similarly, this industry involves a wide variety of parties such as consignor and consignee, freight forwarders and carriers as well as official bodies like customs and port authorities. The combination of logistics channels and parties implies an opportunity to simplify asset and shipment identification using GS1 Identification Keys and sharing this information between carriers and other service providers [16]. Figure 2 shows an architecture of framework EPCIS standard based on information communication technology, standard include for the identification, capturing and information exchange.

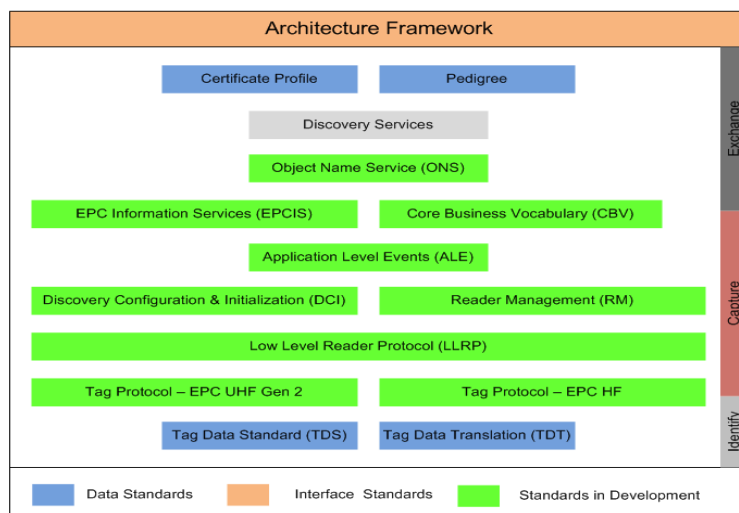


Figure 3. EPCIS architecture framework [16]

The identification of the origin of food sources is prime importance for the protection of consumers, particularly when products are found to be faulty. Traceability facilitates and precisely targets the recall or withdrawal of foods when necessary; enables consumers to be provided with targeted and accurate information concerning implicated products; and is crucial to the investigation of the causes of food poisoning and other contamination outbreaks. Thus traceability is an indispensable feature of food safety. Before there was any attempt to legislate for traceability, responsible food manufacturers, in their own enlightened self-interest, operated their own traceability schemes. The impetus to develop legislation was public and governmental concern in many countries over food poisoning and other contamination outbreaks (including potential bio-terrorism), despite all the food safety legislation that existed. Traceability necessitates that each lot of each food material is given a unique identifier which accompanies it and is recorded at all stages of its progress through its food chain [17]. Figure 4 shows an example of application framework of food product traceability in supply chain management system.

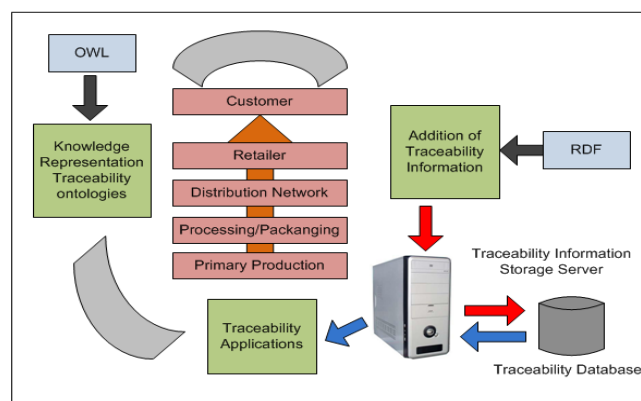


Figure 4. Application framework for food product traceability [17]

Traceability in food supply management system is the efforts to improve food traceability typically identify two major goals, namely speed and accuracy. Standardization will likely improve accuracy, but will not do much to improve speed. Speed and accuracy are both necessary to realize benefits from any food traceability system in terms of illness, lives, waste and inventory control. Regardless of data standardization is simply not capable of providing the speed that will be required by the industry or regulators. Figure 5 shows an example of detail process flow for food product traceability in supply chain management system.

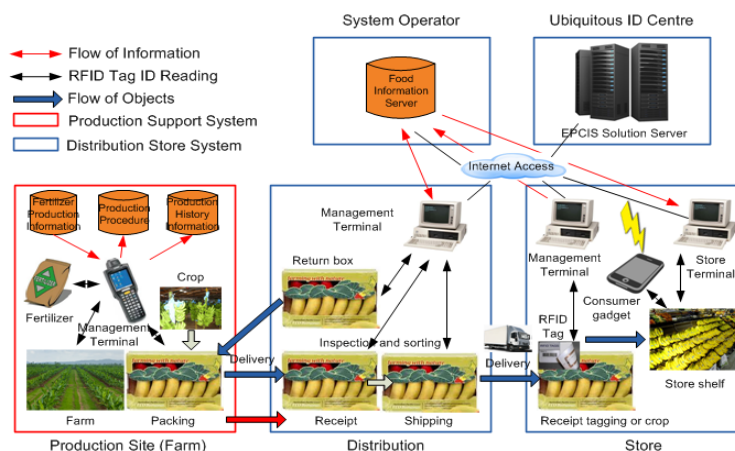


Figure 5. Detail of process flow for food product traceability [17].

4. Food Product Tagging and Identification

In order to identify and track a product, tagging or labeling with identification is required to make a product detected by system. This system used RFID technology as a tool for identification, tracking and traceability thus an RFID tag is needed to stick on product either goods or carton box. In this case a passive RFID tag with inexpensive cost used as a label with some information stored inside the tag, the information represent some important data of the product such as date of expire for food product, farming location (area), manufacturer, supplier and importer. Besides that, with RFID tag product delivery can be track and trace if case happen on the goods for early precaution before reach to the consumer. Figure 6 shows a sample of food product (banana) that tagged on fruit and on carton box, the label on carton box represent number of goods inside then with this system applicable to use in inventory or stockiest for a retailer or supplier.



Figure 6. RFID tagged on a carton box of a product

Every food products either bucket or carton box were tagged by an RFID tag, thus identification and scanning can be done at any place with available facility of fix RFID reader or mobile handheld RFID reader. Normally before product going out to deliver or shipping, a set of RFID system installed at the gate for automatic identification then system will scan and captured the entire food product out. All data captured will send to central database throughout network system, the data collected useable for local system such for record and inventory beside for customer and other parties need the information about food product. Figure 7 shows a system of RFID with fixed reader and mobile handheld reader to identify food products, where every products before loading to the truck should pass by outgoing portal system with installed RFID system with high power of transmission then all the product will detected in longer range (long distance). In some cases because of casing or enclose of product maybe fix reader cannot or difficult to pass by portal system then the mobile handheld reader use for the scanning and identification. Data collected by handheld reader will send to central database as well by wirelessly throughout wireless access point.

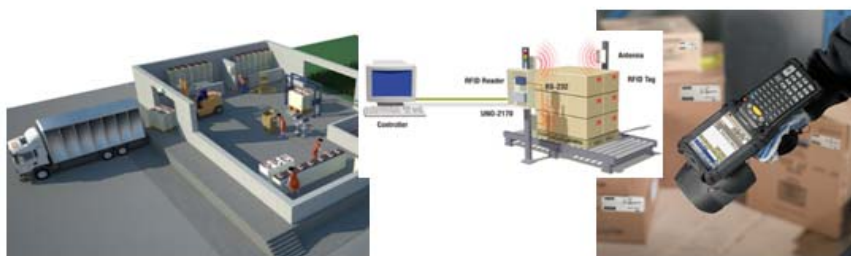


Figure 7. Fix RFID reader and mobile handheld reader

5. Product Verification by Consumer

Customer as user of food product expected every of product safe to consume, thus information is need to identify whether food product still good (not expire) and supplied from

which country or region. Information technology with smart phone or table be able to detect food product with application software installed, mobile equipment very practical to use because of capability to bring anywhere. Beside that nowadays most of mobile devices available with RFID scanner or reader which is Near Field Communication (NFC). User by using application software easily scan selected product to check the information and others related detail of product. Figure 8 shows an example of user scanning of a food product at retail store, product information will query to central database that has been uploading by supplier, manufacturer and freight forwarder and also retailer system. With this system user or customer be able to see all products information including delivery time, supplier, expire date, etc.



Figure 8. An example of user scans a selected food product

6. Conclusion

A system of food product traceability and security based on EPCIS standardization using RFID technology as elaborated has capability to gives user satisfaction to consume the product. Integrated of a few parts of system such as RFID technology, EPCIS database centre, supply chain and application software contribute for improvement in many kind of system. EPCIS standardization in supply chain and food product traceability used, the information data centre can be access by consumer of logistic companies. RFID system available at smart phone or tablet can be use for scanning of product information at retailer before consumer to proceed buying or consume. Big capacity of central database should apply in order huge of data comes from many parties started from manufacturer or industries then freight forwarder and warehouse at retailer shop. This case of sample product of traceability is not limited to food product but any kind of product that required traceability and monitoring system for customer satisfaction. Information provided by the system very useful in order to prevent any case of incident happen in food product before consume by customer.

Acknowledgements

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